Astrobiology Early Career Collaboration Award Post-Travel Summary

Project title:
Raman Spectroscopy for Fossil Biosignature and Mineral Identification on Mars: Challenges and Pathways Forward for Mars Sample Return Missions

I am a 5th year PhD student at Arizona State University's School of Earth and Space Exploration. From Nov. 6-20, 2015, I traveled to the Planetary Exploration Instrumentation Laboratory (PEIL) at York University, Toronto, Canada, investigate the use of PEIL's cutting edge Raman spectroscopy instrument to enable identification of biosignatures and relevant minerals in my high priority Mars analog sample suite. This is a post-travel summary of the trip.

Our collaboration was overall very successful and our anticipated outcomes were achieved. The collaboration resulted in a publication to Planetary and Science Journal (expected submission, June 2016) and likely several conference poster presentations (TBD, 2016) where we will build strong science case coupled with a unique, cutting edge Raman technique that is well-suited to address NASA's recommendations for upcoming Mars missions. Our collaboration enabled clear in situ identifications of Mars analog samples for biosignature exploration, while informing time-resolved UV Raman spectroscopy instrument design and sampling strategies for future Mars Sample Return (MSR) missions based on UV Raman and fluorescence instrumentation. Our study resulted in what we believe can be a significant improvement in the consistency and quality of kerogen identifications using UV time-resolved Raman (TRR) spectroscopy.

This is especially timely because two Raman instruments, including one that is UV wavelength, will fly to Mars for the first time on NASA's Mars 2020 rover. To date, no studies have quantified the science return with UV laser TRR compared to standard Raman in challenging, relevant, high priority Mars analog samples. **In our planned publication, our study will be the first to report on sample-dependent issues and science-driven approaches in time-resolved Raman instrument development to support future MSR missions carrying TRR and UV Raman instruments.**

The team members involved in this project were crucial for its success; this collaboration was a natural match between York's PEIL lab and ASU. PEIL has been developing an instrument combining UV TRR and fluorescence spectroscopy for microscale biosignature and mineral analysis on mission payloads. In parallel, ASU has been investigating high priority analogs for astrobiology exploration on Mars and their preservation potential. Evan Eshelman, a PEIL graduate student, is a PhD student focusing on Raman for Mars astrobiology. He built the UV TRR system that was used in this collaboration. This system turned out to be ideal for the work described; it was in a breadboard configuration and was modified for our specific experiments. Evan aided with all experiments and analyses and will be the second author on the expected publication. Dr. Michael Daly, PEIL lead, Professor and Evan's PhD advisor, is a member of the Canadian Astrobiology Training Program whose goal is to foster collaboration between Canadian scientists and NAI partner institutions. Dr. Daly brought in expertise in instrument development for planetary missions. He led the development of Canada's first instrument on another planet aboard the Phoenix mission. His lab is leading a Canadian Space Agency science definition study on Raman and laser-induced fluorescence for Mars astrobiology. His technical recommendations were useful in optimizing some of our analyses and approaches. He will be third author on our

expected publication. My advisor, Jack Farmer, brought in his expertise in astrobiology and Mars exploration. He is a member of the CheMin instrument team on MSL. His lab at ASU houses the microscope and sample preparation techniques used to prepare and characterize all samples for targeted analyses on PEIL's instrument. He will be fourth author on our expected publication.

The contact information for the PEIL and ASU team leads is as follows:

York University, Planetary Exp. Instr. Lab
Petrie Science Building, Rm. 428
4700 Keele St
Toronto, Ontario
M3J 1P3 Canada
Phone number: 1-416-736-2100 x22066

Jack Farmer Research Laboratory
ASU School of Earth and Space Exploration
550 East Tyler Mall PSF Rm. 686
Tempe, AZ
85287
Phone number: 602-501-0762

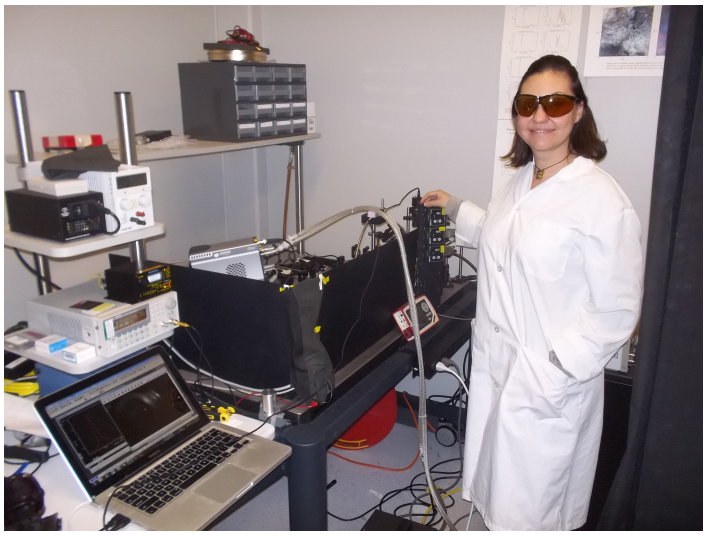
Below you will find some pictures and captions from the trip.

Thank you for your contribution to my research and in turn, supporting NASA's top Mars priorities, through your generous support from the Astrobiology Early Career Collaboration Award. If there is anything else my team or I can provide you, please let us know.

Sincerely,

Svetlana Shkolyar

PhD candidate, School of Earth and Space Exploration, Arizona State University
Office: ISTB4 room 548
sshkolya@asu.edu
(904)891-5348



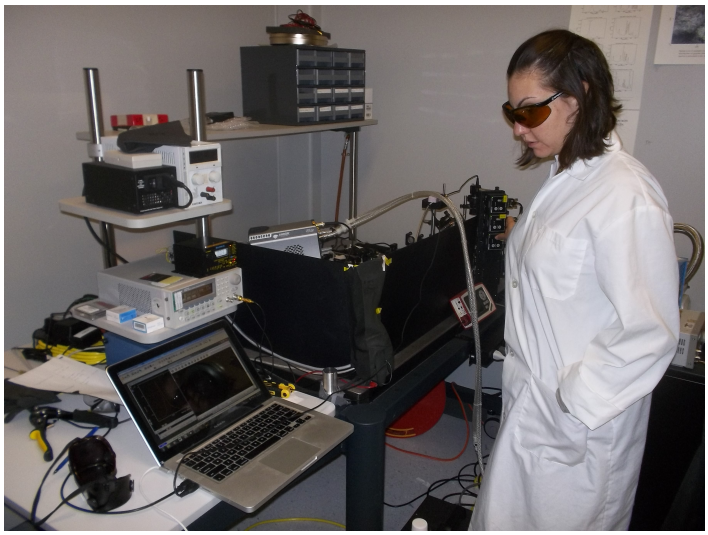


Fig. 1 and 2. Images of Svetlana Shkolyar with UV radiation protection googles in front of the PEIL UV Raman instrument custom built by Evan Eshelman. In the left image, she is controlling the stage on which the sample is sitting.

Fig. 3. PEIL Laboratory lab logo at York University.